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[54] **REFRIGERANT EXPANSION DEVICE**

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[51] **Int. Cl.** **F25b 41/06**

[58] **Field of Search** 62/511, 222, 217; 138/44, 138/45

[56] **References Cited**

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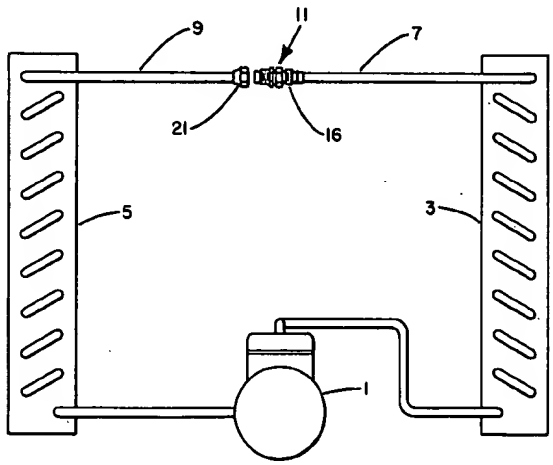
[57] **ABSTRACT**

A refrigerant expansion device comprising a body portion having an expansion conduit extending therethrough, the entrance to the device being planar and generally perpendicular to the direction of refrigerant flow, and the length of the device being relatively small.

4 Claims, 2 Drawing Figures



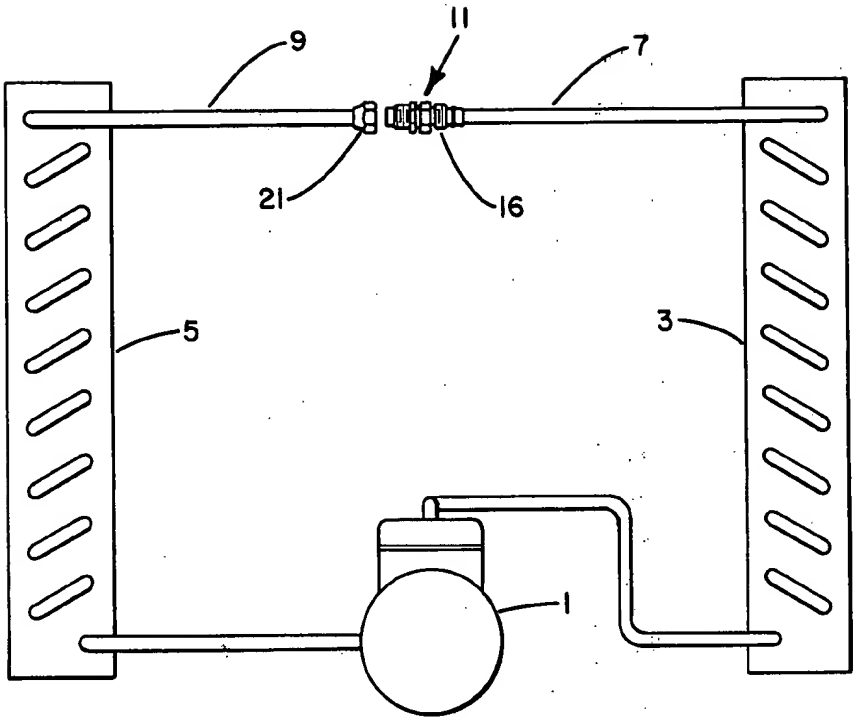


FIG. 1

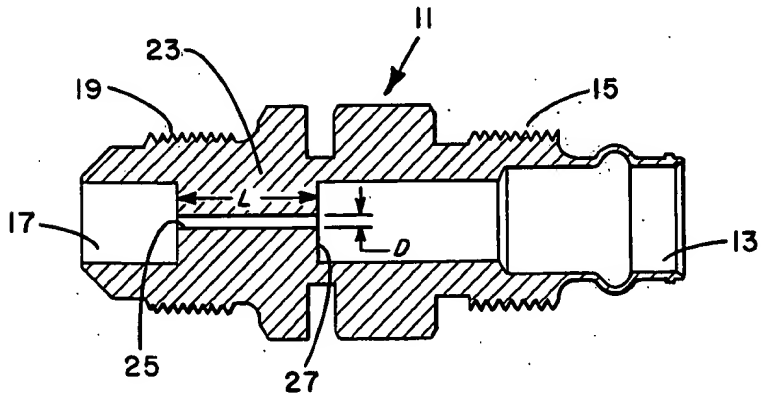


FIG. 2

REFRIGERANT EXPANSION DEVICE

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to refrigerant expansion devices for reducing the pressure of refrigerant flowing from the condenser to the evaporator of a compression refrigeration system.

2. Description of the Prior Art

A compression refrigeration system comprises a compressor, a condenser, an expansion device and an evaporator connected in a circuit to provide refrigeration. Hot compressed refrigerant vapor from the compressor enters the condenser, where it transmits heat to an external heat exchange medium and condenses. Condensed refrigerant at a high pressure flows through the expansion device, where the refrigerant undergoes a pressure drop and at least partially flashes to a vapor. The liquid-vapor mixture flows through the evaporator and absorbs heat from the warm external surrroundings to evaporate and usually superheat the refrigerant. The low pressure refrigerant vapor then returns to the compressor to complete the circuit.

Although the expansion device is often of simple construction, its role in the refrigeration system is crucial. The expansion device should meter refrigerant in a manner such that refrigerant leaving the evaporator is superheated by a controlled, relatively small amount. The foregoing is desired to prevent any damaging liquid from entering the compressor, and to avoid subjecting the compressor to excessive temperatures from highly superheated vapor.

The performance of the expansion device plays a crucial role not only in the reliability of the compressor, but also in the capacity of the refrigeration system. Since the system is a closed circuit, any effect the device has on the low or evaporator side is intimately tied in with the performance of the high or condenser side. Most conventional air conditioning systems incorporating compression refrigeration units of the kind described are designed to have a predetermined cooling capacity at a given ambient temperature (e.g., 95°F). The capacity of the system usually drops at ambient temperatures above the design point, and it is desirable to limit this drop in capacity. It is known that the choice of expansion device has a direct and pronounced effect on the preceding change in the capacity of the system.

There are several known expansion or metering devices. The thermostatic expansion valve is highly effective in use because it meters refrigerant in direct response to the refrigerant vapor temperature in the evaporator. The thermostatic expansion valve (or TXV) is expensive, however, so that its use is limited.

The simplest and most commonly used metering device is the capillary tube. In operation, refrigerant from the condenser enters the capillary and undergoes a frictional pressure drop along the length of the tube. The flash point, which is the point at which the first vapor bubble is formed in the conversion of the refrigerant from its liquid to its vapor state, occurs at some point intermediate the length of the tube. Refrigerant flow is choked (or reaches sonic velocity) at the exit of the tube, and a further pressure drop occurs for several diameters downstream of the capillary. The capillary is inexpensive to manufacture and install, but its efficiency in use is not entirely satisfactory. The main

shortcoming of the capillary tube resides in the fact that the refrigerant flow and flash point of the capillary change with varying operating conditions. The net effects of such changes is to change the extent to which refrigerant leaving the evaporator is super-heated. (This effect is complicated, but in essence occurs because these changes vary the amount of subcooling occurring in the evaporator, which in turn changes the amount of refrigerant stored at any one time in the condenser and in the evaporator.) Therefore, the system parameters must be selected, and the range of operative ambient temperatures must be restricted, to assure the superheating of vapor entering the compressor under all ambient conditions in which the system is designed to operate. These limitations are required to protect the compressor from refrigerant floodback (liquid from the evaporator entering the compressor), at the expense of system capacity, versatility and efficiency.

Another known fixed orifice expansion device is the orifice plate, which comprises a thin plate having an expansion orifice extending therethrough. Orifice plates are small and inexpensive, but they are erratic in performance. Hence, such plates are not in wide use.

In an attempt to provide an alternate expansion device having the economical advantages of the capillary tube, while being smaller and more efficient in operation, the expansion device described in commonly assigned U.S. Pat. No. 3,642,030 entitled "Refrigerant Throttling Device," and issued on Feb. 15, 1972, in the name of Larry D. Amick was developed. That device comprises a body member having a tubular insert having prescribed length-to-bore diameter ratios, a conical inlet, and a conical exit. Analysis of such devices has indicated that most of the pressure drop occurs at the inlet of the device, and that the flash point occurs at the exit of the device. The latter characteristics are significant, for unlike the capillary tube and similar expansion devices, the flash point does not occur inside the device. Therefore, the system inefficiency associated with the variation of flow through the capillary tube is avoided in the Amick device.

SUMMARY OF THE INVENTION

An object of the present invention is to expand refrigerant in a compression refrigeration system in a manner which is economical, efficient, and effective.

A more specific object of the invention is to provide an improved fixed orifice refrigerant expansion device which is susceptible of economical manufacture and effective in performance over a wide range of operating conditions.

Another object of the invention is to provide an improved fixed orifice expansion device of the foregoing type which is of short length to facilitate the manufacture and assembly thereof.

Other objects will be apparent from the description to follow and from the appended claims.

The foregoing objects are achieved according to the preferred embodiment of the invention by the provision of a refrigerant expansion device comprising an elongate body portion having an expansion conduit extending therethrough, and a planar entrance generally perpendicular to the direction of refrigerant flow. The body portion is shorter than presently used fixed orifice expansion devices. Accordingly, the member has a conduit length-to-diameter ratio of from 5 to 12, and a

length of less than one inch. The body portion is a portion of a unitary coupling member for connecting the refrigerant line leading from the condenser of a compression refrigeration circuit to the refrigerant line leading to the evaporator of the circuit.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a schematic representation of a compression refrigeration system incorporating an expansion or metering device according to the present invention, and FIG. 2 shows the device in cross section.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The refrigerant expansion device described below comprises a body portion having an expansion conduit extending therethrough and a flat entrance presenting a sharp edge orifice to incoming refrigerant. The sharp edge entrance orifice effects a major portion of the refrigerant pressure drop at the entrance, so that only a short conduit length is necessary to effect the balance of the pressure drop demanded of the device. The body member is incorporated in a unitary coupling member configured to join refrigerant lines from the condenser and to the evaporator.

Referring now to the drawing, there is shown in FIG. 1 a compression refrigeration system which includes a compressor 1, a condenser 3, and an evaporator 5 connected together by refrigerant lines to form a refrigeration circuit. The refrigerant line 7 leaving the condenser is connected to the refrigerant line 9 to the evaporator by a coupling member 11. Incorporated within and integral with this member is a fixed orifice refrigerant expansion device.

Coupling member 11 is shown in detail in FIG. 2. The coupling member is preferably fabricated from a single mass of material, preferably one which is resistant to corrosion by refrigerant, such as brass. Coupling member 11 includes at its upstream side an expanded portion 13 for receiving the end of refrigerant line 7 leading from condenser 3, and a threaded collar 15 on which a coupling nut 16 (FIG. 1) can be threaded to secure line 7 to the coupling member in a fluid-tight manner. Similarly, the downstream side of coupling member 11 has an expanded portion 17 commensurate in size with line 9, and an external threaded collar 19 for receiving coupling nut 21 (FIG. 1), to secure line 9 to the coupling member in a fluid-tight manner. A body portion 23 is disposed in coupling member 11, and has extending therethrough a small bore refrigerant expansion conduit or orifice 25. The upstream or entrance face 27 of body portion 23 is flat and perpendicular to the direction of incoming refrigerant so as to present to that refrigerant a sharp edge orifice.

The foregoing sharp edge orifice effects a very substantial pressure drop on refrigerant entering conduit 25, and in fact, expands the refrigerant by nearly the entire amount which is required at this stage of the circuit. Since the remaining pressure drop which is necessary is small, the length L of conduit 25 can be accordingly small. Specifically, the length-to-diameter ratio (L/D) should, for optimal performance, fall within the range of from 5 to 12. (If this ratio is too low, the erratic performance of an orifice plate would occur.) In compression refrigeration systems using R-22 refrigerant and three row evaporator coils having from 10 to 13 fins per inch and face areas of from 1.64 and 4.0 square feet, expansion devices of the present type having expansion conduit lengths of 0.5 inches and bores of from 0.042 to 0.094 inches in diameter, have been found to yield excellent results.

The refrigerant expansion device provided by the present invention fulfills the objects set forth above. The device is very efficient and effective in operation. Liquid refrigerant undergoes substantial pressure drop as it enters conduit 25, yet the flash point does not occur until the exit of the conduit. Therefore, liquid refrigerant flows through the expansion conduit and the disadvantages associated with the shifting flash point of the capillary tube are avoided. The expansion device comprising body portion 23 and conduit 25, and the rest of coupling member 11, are fabricated from a single piece of material, and the entire fabrication can be done automatically. By virtue of the small length of conduit 25, the drilling operation for forming the conduit can be done rapidly and accurately. In addition, the reduced length enables material savings. Coupling member 11 can easily be installed at the factory or in the field.

The invention has been described in detail with particular reference to a preferred embodiment thereof, but it will be understood that variations and modifications can be effected within the spirit and scope of the invention.

I claim:

1. In a compression refrigeration system including a compressor, a condenser and an evaporator connected in a refrigeration circuit, a refrigerant expansion device for expanding refrigerant flowing from the condenser to the evaporator, said refrigerant expansion device comprising:

an elongate body portion having a planar surface generally perpendicular to the direction of refrigerant flow; and

an expansion conduit commencing at said planar surface and extending through said body portion said conduit having a cylindrical bore of uniform diameter;

the length of said conduit being from 5 to 12 times the diameter of said conduit.

2. The invention according to claim 1 wherein said body portion comprises a portion of a unitary coupling member for connecting a refrigerant line leading from the condenser to a refrigerant line leading to the evaporator.

3. The invention according to claim 1 wherein the length of said conduit is less than one inch.

4. The invention according to claim 3 wherein the length of said conduit is 0.5 inch.

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